Chapter 3 – The Science Content Standards
Grade Five

INTRODUCTION

Fifth grade students will learn about chemical reactions and discover the special (and shared) properties of metallic elements. They will clearly distinguish between molecules and atoms, and chemical compounds and mixtures, and will learn about the organization of atoms on the Periodic Table of the Elements. They can then be shown how specific chemical reactions (such as photosynthesis and respiration) drive the physiological processes of living cells. They will add to what they have learned in previous grades about the external characteristics and adaptations of plants and animals and learn about some of the fundamental principles of physiology, They will learn about blood circulation and respiration, digestion of food and collection and excretion of wastes in animals, and about how plants move water and minerals from the roots to the leaves, and transport sugar generated during photosynthesis from the leaves to the other parts of the plant. Fifth grade students also study the hydrologic cycle (water cycle), the process by which water moves between the land and the oceans. They will learn how the hydrologic cycle influences the distribution of weather-related precipitation and, as a consequence, the types and rates of erosion. They will also study the solar system and learn that it contains smaller asteroids and comets in addition to the sun, nine planets, and moons. They will learn about the composition of the sun and the relationship between gravity and planetary orbits.

The Science and English-Language Arts Standards are complementary so that the writing strategies will lay a foundation for good science report writing and for giving informative oral science presentations. The Science and the Mathematics Content Standards for California Public Schools also reinforce each other as students analyze, strategize, and solve problems, finding solutions to apply to new circumstances. Fifth grade students will also develop testable questions and learn to plan their own investigations, selecting appropriate tools to make quantitative observations.

STANDARD SET 1: Physical Sciences

Background

Students will have some familiarity with the idea of atoms and elements from third grade. In fifth grade, the introduction to chemical reactions and the concept that atoms combine to form molecules requires students to clearly distinguish between molecules and atoms, and chemical compounds and mixtures. They will be introduced to the idea that the organization of atoms on the Periodic Table of the Elements is related to similarity and trends in the chemical properties of the elements.

1. <u>Elements and their combinations account for all the varied types of matter in the world.</u> As a basis for understanding this concept:

a. Students know that during chemical reactions the atoms in the reactants rearrange to form products with different properties.

The properties of a chemical compound are controlled by how atoms of different elements combine to make the compound. During a chemical reaction between two compounds, none of the original atoms is lost but they may rearrange themselves into new combinations, resulting in the formation of new products with properties that differ from those of the reacting compounds. There are simple and safe chemistry experiments that are described in fifth grade science texts, and students can identify reactants and products when observing chemical reactions.

b. Students know all matter is made of atoms, which may combine to form molecules.

The fact that atoms can combine to form molecules is new information and students should be given the opportunity to practice the correct use of these terms. The number of different types of atoms is relatively small in comparison to the large number of different types of molecules that can be formed. Simple molecules (such as nitrogen, oxygen, water, carbon dioxide, methane, and propane) can be easily represented by molecular models, and this can enhance students understanding of the symbolic representations in text. The idea of "combinations" of atoms sets the stage for learning about chemical bonds in high school.

c. Students know metals have properties in common, such as high electrical and thermal conductivity. Some metals, such as aluminum (Al), iron (Fe), nickel (Ni), copper (Cu), silver (Ag), and gold (Au), are pure elements; others such as steel and brass, are composed of a combination of elemental metals.

Elements are grouped together on the Periodic Table of the Elements according to their chemical properties which, in turn, are based upon the atomic structure of these elements. All pure, elemental metals share some properties in common such as high electrical and thermal conductivity. These same properties persist when elemental metals are combined to form alloys, i.e., copper and zinc to make brass.

Students may be familiar with many metallic elements (e.g. gold, silver, copper, zinc, aluminum, lead, mercury, chromium) and common metal alloys (e.g. brass, steel, bronze, pewter). It would be helpful for teachers to obtain samples of some of these metals and alloys for students to study. [***Caution*:** Some heavy metals (such as lead, mercury, and chromium or their salts) may be hazardous.] Metals are, in general, shiny, reflecting most of the light that strikes them. They are malleable and ductile (that is, they will bend under pressure and are not brittle). They have a broad range of melting temperatures, from mercury which is a liquid at room temperature, and gallium which will melt in your hand, up to tungsten with a melting temperature around 3,400 degrees Celsius. The thermal and electrical conductivity for all metals is high compared to non-metallic substances such as plastics and ceramics, rocks and solid salts. Given the appropriate tools, students can develop tests for metals and non-metals to see if they conduct electricity and heat.

d. Students know that each element is made of one kind of atom and that the elements are organized in the periodic table by their chemical properties.

All matter is made of atoms. The word "element" refers to those substances that repeated experiments have shown cannot be reduced to still more “elementary” substances. The explanation for this fact is that elements are made of many identical atoms. Water was considered an element at one time. However, it is possible to electrolyze water and produce hydrogen and oxygen gas, both

elements. Properties of elements are determined entirely by their atoms. Therefore, we say elements are made of "one kind of atom" that gives the element its unique properties. The history of the discovery and naming of any one of the elements provides insight into the nature of science and scientific progress. The single most important property of an element is its atomic number. This number can be found on the Periodic Table in the box along with the symbol and name of the element. Students should know that atomic numbers increase as you read from left to right, and moving line-by-line down the Periodic Table.

In eighth grade, students will be taught that physical and chemical properties of elements are based on the internal structure of an element's atoms. The Periodic Table was originally constructed based on the increasing atomic weights of the elements. These elements were organized in the pattern of a table, much like a monthly calendar, so that elements with similar chemical properties (e.g., metals, halogens and noble gases) are grouped together in columns. The table gets its name because of the repeating or "periodic" sequences of chemical properties. Students should examine the Periodic Table of the Elements and be able to locate elements by name. They should be able to find common metallic elements on the table, and learn to refer to the table as they study and experiment with substances whose names are composites of the elements, such as sodium chloride and carbon dioxide.

e. Students know scientists have developed instruments that can create discrete images of atoms and molecules that show that the atoms and molecules often occur in well-ordered arrays.

The technique of electron microscopy has opened the door to a new generation of analytical tools that can be used to produce images of individual atoms in a crystalline array. These images show atoms as "fuzzy balls" aligned in orderly and repeating patterns. From these images it is possible to infer that atoms are discrete objects of finite size and nearly spherical shape. Students can see images in textbooks and on the Internet that were obtained using atomic-resolution instruments such as electron microscopes and scanning tunneling microscopes. These images confirm, as hypothesized from years of indirect experimental evidence, that atoms are arranged in orderly arrays in metals and crystals. They also show micro-fractures where the order is interrupted, which can affect the strength of the material.

f. Students know differences in chemical and physical properties of substances are used to separate mixtures and identify compounds.

Students should know the difference between mixtures and compounds. In compounds, atomic constituents are separated by chemical rather than by physical means. In addition, every compound has a unique set of chemical and physical properties that can be used to identify it. Compounds and classes of compounds can be identified by chemical reactions with other compounds. An example is the iodine starch reaction. Other chemical reactions in solution can be explored to identify compounds based on changes in acidity, formation of precipitates, and changes in color. In mixtures, the atomic constituents are separated by their physical properties. Fifth grade science texts will provide simple and safe activities. For example, iron filings can be separated from non-metallic materials by use of a magnet, and a piece of filter paper can be used to separate suspended particles in a solution.

g. Students know properties of solid, liquid, and gaseous substances, such as sugar ($C_6H_{12}O_6$), water (H_2O), helium (He), oxygen (O_2), nitrogen (N_2), and carbon dioxide (CO_2).

This standard builds on the previous one by challenging students to describe and identify a few common elements and compounds based on their observed chemical properties. Students can also study the three common physical states of matter for each of these compounds or elements, as well as learn about and compare such properties as solubility in water, boiling and freezing points, sublimation, and reactivity.

h. Students know living organisms and most materials are composed of just a few elements.

By weight, 98.59 % of the entire crust of the earth consists of eight elements: oxygen, silicon, aluminum, iron, calcium, sodium, potassium, and magnesium. There are nearly 3,500 known minerals in the Earth's crust. This shows that the complexity of the crust is also the result of a small number of elements in a large variety of combinations. Similarly, living organisms are mostly composed of the elements carbon, oxygen, hydrogen, nitrogen, sulfur and phosphorus. The number of types of atoms used as "building blocks" is relatively small. It is the way that the atoms are organized into molecules that provides variety.

i. Students know the common properties of salts, such as sodium chloride (NaCl).

Elements and compounds can be described and identified based on their observed chemical and physical properties. Salts are compounds made from a metal and a nonmetal. Many salts are hard, brittle, and have high melting temperatures. Most salts are soluble in water. When dissolved, they become conductors of electricity.

Salts are made when strong acids react with strong bases. For example, in the reaction of hydrochloric acid (HCl) with sodium hydroxide (NaOH), hydrogen (H) combines with hydroxide (OH) to form water while sodium (Na) and chlorine (Cl) ions remain in solution which, if evaporated, would leave sodium chloride (NaCl) salt. Although the use of strong acids and bases in elementary classrooms would present a significant safety risk, science materials adopted for fifth grade instruction describe simple experiments that can be safely conducted.

There are many different types of salts, but the general use of the term "salt" refers to sodium chloride, the most common and widely used. In science, salts are most often (but not limited to) those substances formed by elements in the groups under sodium and magnesium in combination with elements under fluorine. Some salts can be poisonous and students should be taught that it is good chemical experimental practice to not ingest any substances used or produced in an experiment.

STANDARD SET 2: Life Sciences

Background

In first grade, students were presented with a simple example of the relationship between structure and function; namely that the shapes of teeth are related to the types of materials animals eat. They subsequently learned to identify this phenomenon as an "adaptation." Much of the discussion to this point has focused on external characteristics, but plants and animals have internal structures as

well that perform vital functions. This subject, which is commonly called physiology, is developed still further in seventh grade and in high school.

Description of the Standards

2. Plants and animals have structures for respiration, digestion, waste disposal, and transport of materials. As a basis for understanding this concept:

a. Students know many multicellular organisms have specialized structures to support the transport of materials.

Multicellular organisms usually have cells deep within them that need to receive a supply of food and oxygen, and in the case of animals to have cellular wastes removed. In higher animals, blood circulation is responsible for the transport of glucose sugar to each cell, the provision of oxygen, and removal of cellular wastes and carbon dioxide. Cutting the bottom end off a stalk of celery and placing it in water containing food coloring can demonstrate the transport of water in a plant. After the colored water is taken up into the plant, students can make cross sections of the celery and observe the sections under microscope. For plants, this standard can be taught in the context of standard 2e that follows.

b. Students know how blood circulates through the heart chambers, lungs, and body and how carbon dioxide (CO_2) and oxygen (O_2) are exchanged in the lungs and tissues.

Structures of the cardiovascular and circulatory systems, including the heart and lungs, promote the circulation of blood and gas exchange. The left side of the heart is responsible for pumping blood through arteries to all of the tissues of the body and delivering oxygen. Oxygen-poor blood returns to the heart through veins, and the right side of the heart is responsible for pumping this blood to the lungs where the blood eliminates its carbon dioxide and receives a fresh supply of oxygen. Exhaling expels the carbon dioxide that was carried to the lungs by the blood; inhaling allows the intake of oxygen for the blood to pick up.

c. Students know the sequential steps of digestion and the roles of teeth and the mouth, esophagus, stomach, small intestine, large intestine, and colon in the function of the digestive system.

Digestion starts in the mouth, where chewing breaks up food into smaller pieces that can be easily swallowed and digested. Saliva contains compounds that are also important in breaking down food. The esophagus is a tube that moves food from the mouth to the stomach after swallowing. In the stomach, the food is mixed with stomach acids that help to break down the food into parts that can be absorbed. Once it reaches the small intestine, food is neutralized and processed into molecules that can be absorbed into the blood supply. The large intestine recovers water from food and the colon collects fecal waste (indigestible parts of food) and stores it prior to elimination from the body.

d. Students know the role of the kidney in removing cellular waste from blood and converting it into urine which is stored in the bladder.

Cells in living organisms produce waste products that they cannot recycle into other compounds. The focus of this standard is on the systems that remove waste from the cells to prevent it from accumulating and eventually poisoning the organism. Cellular waste products (in the form of molecules) are separated from the blood stream by the kidneys, stored in the bladder as urine, and removed from the body by urination. In plants, many such waste products are stored in a large central vacuole in each plant cell -- a kind of garbage dump that is gradually filled as the cell ages.

e. Students know how sugar, water, and minerals are transported in a vascular plant.

The xylem of plants is a woody tissue responsible for water and mineral transport from roots to leaves. Water moving up the plant stem replaces water that has evaporated from the leaves. Plants also transport sugar from the leaves to the roots through a living structure of tubes called the phloem.

f. Students know plants use carbon dioxide (CO_2) and energy from sunlight to build molecules of sugar and release oxygen.

Photosynthesis is the process by which plants capture the energy of the sun and use it to initiate a chemical reaction between carbon dioxide and water that results in the production of sugar molecules and the release of oxygen molecules. The chemical process and equation are:

energy + carbon dioxide + water react to form sugar + oxygen

energy + 6 CO_2 + 6 $H_2O \rightarrow$ $C_6H_{12}O_6$ + 6O_2.

The sugar made during photosynthesis is just an initial compound the plant produces. All of the other organic molecules are made by modification of this simple compound. For example, a significant portion of the mass of a log from a tree was once carbon dioxide gas in the air, captured by the leaves of a tree and fixed into larger organic molecules by the equation shown above. The sugar transport processes in the tree are also important in moving the products of photosynthesis down to the stem where they could then become part of the tree.

g. Students know plant and animal cells break down sugar to obtain energy, a process resulting in carbon dioxide (CO_2) and water (respiration).

Cellular respiration is a process of producing energy by the chemical breakdown of carbohydrate (sugar) molecules. This is the reverse of photosynthesis. The chemical process and equation are:

sugar + oxygen react to form carbon dioxide and water,

$C_6H_{12}O_6 + 6O_2 \rightarrow 6\ CO_2 + 6H2O$.

Carbon dioxide and water are reaction by-products. Both plants and animals break down sugar to release its chemical energy in a form they can use. This process is called cellular respiration. The released energy is in a form that organisms can use. In animals, the carbon dioxide is released into the blood where it can be transported to the lungs. In the lungs, carbon dioxide and oxygen are

exchanged (which is the other use of the term "respiration") during the act of breathing. It is important to note that cellular respiration is not the same as breathing.

STANDARD SET 3: Earth Science - Earth's water

Background

The hydrologic cycle (water cycle) is the process by which water moves between the land and the oceans. Fifth grade students learn that cooling in the atmosphere returns water vapor to a liquid or solid state as rain, hail, sleet or snow. They are also presented with factors that control clouds, precipitation, and other weather phenomena.

Description of the Standards

3. Water on Earth moves between the oceans and land through the processes of evaporation and condensation. As a basis for understanding this concept:

a. Students know most of Earth's water is present as salt water in the oceans, which cover most of Earth's surface.

Because water covers three-fourths of the earth's surface, our planet is sometimes referred to as the "Blue Planet." Fresh water falls as rain on land and oceans alike. When it falls on land, the water dissolves salts and other mineral matter and carries them to the oceans. When water evaporates from the surface of the ocean the salts remain behind and accumulate. For this reason, the oceans have become salty. Students should know that the amount of fresh water on land is small compared to the water in the oceans. Using science texts aligned with the Science Content Standards for California Public Schools or a variety of library and other resources, students should be able to trace diagrams of the water cycle and understand what they represent.

b. Students know when liquid water evaporates, it turns into water vapor in the air and can reappear as a liquid when cooled or as a solid if cooled below the freezing point of water.

Liquid water evaporates and becomes invisible vapor when warmed by the sun. Water vapor mixes with the air as it moves through the atmosphere. When the air is cooled, a fraction of the water vapor changes back to liquid water in the form of clouds or rain. If the air temperature becomes low enough, the water will crystallize into a solid state as snow, sleet, or hail. Alternating periods of evaporation and precipitation drives the hydrologic cycle. As a lab demonstration, a teacher can boil water to produce water vapor and direct the vapor onto the cold outside surface of a beaker filled with ice water. The precipitated water vapor will fog the outside of the beaker with tiny drops of liquid water.

c. Students know water vapor in the air moves from one place to another and can form fog or clouds, which are tiny droplets of water or ice, and can fall to earth as rain, hail, sleet, or snow.

Atmospheric circulation moves water vapor, clouds, and fog from one place to another. The tiny droplets or crystals of water that form fog and clouds are so small they remain suspended in the

air. Further cooling of the air can cause these droplets or crystals to grow sufficiently in size to the point where they will fall to the earth as rain, hail, sleet, or snow. By learning basic meteorology from texts, and monitoring and plotting local weather data reported by the news media, students can explore the relationship between the amount of water vapor in the air (humidity), air temperature, and the likelihood of rainfall or snowfall.

d. Students know that the amount of fresh water located in rivers, lakes, underground sources, and glaciers is limited, and that recycling and decreasing the use of water can extend its availability.

Students learn that water quality is affected by various uses and they should be taught about local, state, federal, and global efforts to manage water resources. In California, water resources depend on the use of annual rainwater (and snowpack water) collected in watershed districts, pumping of groundwater, import of water from rivers, and reclamation of water that has been used. Water quality in streams is affected by the disturbance or development of land in a watershed area, run-off of water from farms and city streets, and projects to control the flow of rivers in a flood basin.

e. Students know the origin of the water used by their local communities.

Students learn the origins of the local water supply through a study of the watershed, creeks, rivers, aqueducts, dams, and reservoirs that serve as its source. Student should know if their community's balance between water supply and demand varies seasonally and if conservation and reclamation techniques are practiced. If water is imported, students should be able to trace it back to the supplying localities.

STANDARD SET 4: Earth Sciences – Weather

Background

Fifth grade students learn about the causes of large and small-scale movements in the atmosphere. They apply knowledge of the hydrologic cycle to understanding weather and weather patterns.

Description of the Standards

4. Energy from the sun heats Earth unevenly, causing air movements that result in changing weather patterns. As a basis for understanding this concept:

a. Students know uneven heating of Earth causes air movements (convection currents).

The atmosphere and surface of the Earth are heated unevenly, giving rise to both local and global temperature differences. For example, the direct heat absorbed by the surface of the ocean, land, and air can result in different temperatures. Furthermore, the amount of heat varies with latitude, primarily due to the height of the sun in the sky. The lower the sun's elevation, the less direct its radiation and the less radiation that falls on each square meter of the earth's surface area. This is a result of geometry and it depends on the angle at which the sun's rays intersect the earth's surface at a

locality. When the incoming rays of the sun intersect the earth's surface at a more oblique angle, the solar flux is spread out over a wider area. Polar Regions are cold because the sun is low in the sky and its rays fall at very large angles. Closer to the equator, the sun's rays fall more directly and it is hot. The uneven heating results in local and global temperature differences that create convection currents in the oceans and atmosphere. Fifth grade students should know that warm air rises and cold air falls toward the surface of the earth, setting up convection currents in the air that we call winds.

Convection is an important mechanism in moving heat around in the Earth's mantle, in its oceans, and in its atmosphere. The process of hot air rising and cold air sinking occurs at the Earth's surface on many different scales, causing local winds, as well as great global air currents such as the trade winds.

b. Students know the influence that the ocean has on the weather and the role that the water cycle plays in weather patterns.

Because the Earth is a sphere, equatorial regions receive more concentrated sunlight than Polar Regions. Temperatures are therefore higher at the equator than farther north or south, but the difference would be much more extreme without the influence of the oceans, which cover about 70% of the earth's surface. Water can absorb (or release) a great deal of heat without changing its temperature very much. The oceanic circulation carries water warmed near the equator to both the north and to the south. These great ocean currents gradually release heat to the atmosphere, helping to distribute heat from place to place on the Earth. The presence of warm surface currents, such as the Gulf Stream, makes high latitude countries such as Scotland more habitable than they would otherwise be. Moreover, a great amount of equatorial heat is absorbed by water as it evaporates. Global atmospheric currents (winds) carry this heat to cooler regions and this heat is released to the atmosphere as water condenses, forming precipitation. Thus heat as well as water is transported. This is another important mechanism for evening out temperatures on the earth. Because large bodies of water can absorb or release so much heat without changing temperature, their temperature is fairly constant from day to night and from season to season. Air in contact with large bodies of water is therefore "tempered" - warmed in the winter and cooled in the summer. The amount and distribution of precipitation depends a great deal on the surface temperature of the water. When water temperatures change, even a little, large changes in weather (or even climate) may occur. A good example of this is the ENSO cycle (El Nino/Southern Oscillation) which brings especially wet and dry seasons to many places around the world.

c. Students know the causes and effects of different types of severe weather.

There are many types of severe weather on the earth: hurricanes, tornadoes, thunderstorms, and monsoons. The source of energy for all weather is the sun which heats air and water unevenly. Warm air tends to be less dense than cold air and air will always flow (blow) from areas of high pressure (denser air) toward areas of lower pressure, creating winds. Warm air also can hold more water than cooler air. When warm air is suddenly cooled by contact with cold air precipitation may result. This is the origin of frontal weather systems. Also, when a patch of warm, low-pressure air is surrounded by higher-pressure air (called a low pressure "closure"), the warmer air will tend to rise and be replaced, through convection, by high-pressure air flowing in from all around. Because the earth rotates on its axis, all such winds are deflected (turned to the right in the Northern Hemisphere and to the left in the southern) and the net effect is a circular wind which surrounds the low-pressure

closure. The rising warm air in the center cools, its water condenses, and precipitation occurs. This is known as a cyclone and it is the cause of many big hurricanes and other storms.

d. Students know how to use weather maps and data to predict local weather and know that weather forecasts depend on many variables.

Weather maps display data on air temperature, pressure, and precipitation. If students know that air flows from regions of high pressure to regions of low pressure (and turns to the right in the Northern Hemisphere) they can look at a weather map and predict the direction the wind will blow. If they know, for example, that weather fronts tend to move from west to east in North America, they can predict tomorrow's weather in one place by checking on today's weather somewhere else. And if they see low-pressure closures (discussed above) they can predict stormy or fair weather from high-pressure closures. Very small changes in temperature and pressure may, however, significantly change all such patterns over a few days (the so-called chaos theory). This is why long-term weather forecasts tend to be unreliable.

e. Students know that the earth's atmosphere exerts a pressure that decreases with distance above earth's surface and that at any point it exerts this pressure equally in all directions.

Atmospheric pressure is the weight of air (a force) pushing on a given square unit area (e.g.: m^2 or cm^2). Air is invisible, hard to detect by sense of touch, and difficult to weigh. It works against intuition to think of air as being able to exert pressure. Nonetheless, air has mass and anything with mass is pulled by gravity toward the earth's center. This means that atmospheric pressure is greatest near the surface of the earth at sea level and diminishes with increasing height in the atmosphere. This effect is used by airplane pilots to measure altitude reliably with barometric pressure at sea level serving as a reference point. It also means that the pressure exerted on the bottom of an object, such as a balloon, is slightly greater than the pressure on the top. It should be noted that the second part of this standard is a reminder that direction of the "push" caused by the pressure is the same in all directions -- up, down, or sideways. The same principle holds true for pressure in any fluid.

STANDARD SET 5: Earth Sciences - The Solar System

Background

Student knowledge of the solar system includes a descriptive understanding of the relative motions of the planets. Students have been already been introduced to the fact that the Earth orbits the sun, and the moon orbits the Earth. Fifth grade students learn about the composition of the sun and the fact that the solar system includes smaller asteroids and comets in addition to the sun, nine planets, and moons. They also develop a basic understanding of the relationship between gravity and planetary orbits.

Description of the Standards

5. The solar system consists of planets and other bodies that orbit the sun in predictable paths. As a basis for understanding this concept:

a. Students know the sun, an average star, is the central and largest body in the solar system and is composed primarily of hydrogen and helium.

The sun is about one million times the volume of the Earth. Its mass can be calculated from the shapes and positions of the planetary orbits, resulting from gravitational attraction between the sun and its planets. The fusion of hydrogen to helium is responsible for most of the sun's energy.

b. Students know the solar system includes Earth, the moon, the sun, eight other planets and their satellites, and smaller objects, such as asteroids and comets.

The solar system includes nine planets in order from the sun: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto. Most of the planets have moons in orbit about them but only Earth's moon is visible with the unaided eye. Asteroids and comets are smaller bodies in mostly irregular orbits about the sun. Many science texts and web sites provide information and photographs of objects in the solar system, collected from NASA's planetary, comet, and asteroid missions, and Earth and space telescopes.

c. Students know the path of a planet around the sun is due to the gravitational attraction between the sun and the planets.

Planets move in elliptical, nearly circular orbits about the sun. They are held in these orbits by gravitational attraction. The moon also travels in a nearly circular orbit around the earth. Each object in the solar system obeys the laws of physics by moving in a straight line until pulled or pushed by a force. Gravity causes a pull or attraction between the mass (matter) of each of the planets and the mass (matter) of the sun. This constant pull continually deflects a planet's path toward the sun as it completes its orbit.

Students may wonder why the pull of gravity does not cause the planets to "fall" into the sun or the moon into the Earth. One way to explain this is that the planets and moon are in fact falling, but they are also moving very fast to the side. As the moon is pulled toward the earth it also moves forward creating the curved path of its orbit. Thus the moon is constantly falling, but the downward and sideways motion are exactly balanced so the moon never gets closer or father away. In the same way, the planets are maintained in orbits around the sun. Understanding that gravity exists in outer space may be made more difficult by the images of astronauts floating "weightless" in their capsules. When these pictures are taken, the astronauts are in orbit around the earth and are essentially free falling (just like the moon).

STANDARD SET 6: Investigation and Experimentation

Background

Questions that are testable in science are founded in factual information, and based on observations. When students plan an experiment based on their questions, they must decide what the variables are or what properties or sequence of events will change throughout the experiment. Students will observe and measure a change in one of the properties or event sequences in their

experiment. The experiment is complete when the students draw conclusions and make inferences in a written and/or oral report.

Text of the Standards

6. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:

a. Classify objects (e.g., rocks, plants, leaves) in accordance with appropriate criteria.
b. Develop a testable question.
c. Plan and conduct a simple investigation based on a student-developed question and write instructions others can follow to carry out the procedure.
d. Identify the dependent and controlled variables in an investigation.
e. Identify a single independent variable in a scientific investigation and explain how this variable can be used to collect information to answer a question about the results of the experiment.
f. Select appropriate tools (e.g., thermometers, meter sticks, balances, and graduated cylinders) and make quantitative observations.
g. Record data using appropriate graphic representation (including charts, graphs, and labeled diagrams) and make inferences based on those data.
h. Draw conclusions from scientific evidence and indicate whether further information is needed to support a specific conclusion.
i. Write a report of an investigation that includes conducting tests, collecting data or examining evidence, and drawing conclusions.